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SOME COMMON MAMMALS OF WESTERN MONTANA IN RELATION TO AGRICULTURE AND SPOTTED FEVER.

BY

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Biological Survey,
Washington, D. C., January 4, 1912.

Sir: I have the honor to transmit herewith and to recommend for publication as a farmers' bulletin a report on Some Common Mammals of Western Montana in Relation to Agriculture and Spotted Fever, by Clarence Birdseye, assistant in the Biological Survey. The investigations on which this report is based were carried on in western Montana for several years, especially in the Bitterroot Valley, in cooperation with the Bureau of Entomology and the Montana State Agricultural Experiment Station. As Rocky Mountain spotted fever is transmitted to man by wood ticks and as the earlier stages of these insects are passed almost wholly on native wild mammals, some of which are exceedingly destructive to crops, the facts here presented have an important bearing on human health as well as on agriculture.

Respectfully,

Henry W. Henshaw,
Chief, Biological Survey.

Hon. James Wilson,
Secretary of Agriculture.

[A list giving the titles of all Farmers' Bulletins available for distribution will be sent free upon application to a Member of Congress or the Secretary of Agriculture.]

CONTENTS.

ILLUSTRATIONS.

SOME COMMON MAMMALS OF WESTERN MONTANA IN RELATION TO AGRICULTURE AND SPOTTED FEVER.

INTRODUCTION.

There are few localities in the West where the commoner species of native mammals, especially rodents, are so important as in certain parts of western Montana; for there they must be considered in relation not only to agriculture but also to the Rocky Mountain spotted fever. Especially serious is the damage done to crops and young orchards by ground squirrels, pocket gophers, and rabbits; while in areas intended to be reforested the destruction of the tree seed by chipmunks and white-footed mice renders the extermination of these rodents necessary.

The Rocky Mountain spotted fever is a germ disease which is communicated from wild animals to human beings by the bite of the spotted-fever tick (*Dermacentor venustus*). In a number of experiments carried on by Dr. H. T. Ricketts [1] and others, spotted fever has been repeatedly communicated to healthy guinea pigs by the bites of wood ticks which had previously fed on animals sick with the fever. Not only has the fever been thus carried from one guinea pig to another, but it has been communicated directly to these animals by ticks picked up in regions where cases of the fever are known to have been contracted by men. Moreover, the germ which causes spotted fever is transmitted from infected female ticks to their offspring, and in a number of experiments the disease has actually been communicated simply by the injection into a healthy guinea pig of a few crushed eggs of an infected tick. Such experiments as these—and numbers have been made, all with similar results—are enough to prove that ticks can and do transmit spotted fever. Only a small percentage of ticks, however, even in the worst "fever country," are infected, and thus people may be bitten by ticks many times without bad results. Moreover, infected ticks may bite people and communicate the disease and then become detached without being noticed, there thus being in such cases no assignable cause for the infection.

One of the current local theories is that spotted fever is caused by drinking impure or very cold water—in other words, that the

[1] Fourth Biennial Report (for 1907 and 1908) of State Board of Health of Montana, pp. 106–111 and 161–183.

fever is contracted through the digestive system. Of course the drinking of bad water may, and undoubtedly often does, cause sickness. But that neither water nor anything else when taken into the stomach can possibly cause spotted fever is proved by the fact that even infected blood has been fed to guinea pigs, which are very susceptible to this disease, without bad results. In short, spotted fever, like malaria, is believed to be contracted only by blood infection, and not, like typhoid, through the digestive system.

In the brief life history of the tick there are four distinct stages—egg, "seed" or larva, nymph, and adult. Although the adult ticks have been found on mountain goats, coyotes, badgers, woodchucks, snow-shoe rabbits, and on the only bear examined, by far the greater number, at least 95 per cent, feed on domestic stock. When full of blood the females drop from their hosts to the ground, become inactive, and after a time lay as many as 4,000 eggs. They then die. After several weeks these eggs hatch, the young ticks, called seeds, being about the size of mites. These seeds then crawl up blades of grass or other low vegetation and, if opportunity offers, become attached to some passing small animal. After feeding on this animal for from three to eight days they become full of blood, drop off, and seek shelter. Then, after remaining inactive for a few days, they molt and emerge as nymphs, which somewhat resemble wood ticks, but are very much smaller. These nymphs, like the seeds, attach to some small animal—never, so far as known, to men—feed for a few days, drop off, become inactive, molt, and after about two weeks emerge as the third and last stage, the familiar wood tick. Thus the life cycle is completed in from one to three years.[1] Any tick failing to find a host in any one of the three stages dies of starvation.

Since it is known that spotted fever is communicated from wild animals to human beings by the bite of infected wood ticks and that the two younger stages live almost entirely on small native rodents—from which they occasionally contract the infection—it is evident that these tick hosts should be destroyed, at least around ranches. The extensive damage done by the same animals to agricultural interests is another important reason for their destruction.

The chief purpose of this publication is to point out the best methods of destroying these native mammals. The investigations on which it is mainly based have been carried on for several years in the Bitterroot Valley, Mont., by the Biological Survey in cooperation with the Bureau of Entomology and the Montana Agricultural Experiment Station. During the seasons of 1910 and 1911 the author, representing the Biological Survey, worked in coopera-

[1] For detailed information in regard to the life history of the tick see Bull. 105, Bureau of Entomology.

tion with Mr. W. V. King, of the Bureau of Entomology, to whom he is indebted for many of the data concerning the host relations of the ticks, as well as for many observations on the distribution and habits of the mammals treated herein.

POISONING RODENTS.

Poisoning is in many cases the most effective and least expensive means of destroying harmful rodents; but methods of poisoning to be successful must be carefully worked out with reference to particular kinds of animals and localities. The formulas given in this bulletin should be closely followed, as the amounts of poison recommended have been carefully determined.

SOME COMMON RODENT POISONS.

Strychnine, arsenic, and phosphorus are the three most generally used rodent poisons. The following is a brief summary of the characteristics of each:

Strychnine is a vegetable poison obtained from the bean of the nux vomica tree, the chief supply coming from the Malabar coast, India. The strychnine of commerce consists of colorless crystals or white powder, and there are two forms commonly used as rodent poisons—the alkaloid and the sulphate. The alkaloid is only slightly soluble in water, and in rodent poisons is usually powdered and applied to grain in a coating of starch or flour paste. The sulphate dissolves readily in either hot or cold water and is used in solution. Both are deadly and act very quickly, causing tetanus, convulsions, and a speedy and comparatively merciful death. The bitterness of strychnine is the chief drawback to its use, because ground squirrels, chipmunks, and some other rodents refuse to eat bitter baits when their natural food is plentiful. The addition of saccharine to strychnine baits has formerly been recommended, but recent experiments have shown that it does not conceal the bitterness of the poison, and is therefore of little value. Although an expensive poison, strychnine is so powerful that it is on the whole more economical than arsenic or phosphorus, and its use is strongly recommended by the department.

Yellow phosphorus is extensively used as a poison for ground squirrels, rats, prairie dogs, and other rodents. But although it is both cheap and effective, the great personal danger accompanying its use and the fact that it causes a painful, lingering death are such serious objections that the Department of Agriculture strongly advises against its use.

White arsenic is an almost tasteless, insoluble, rather weak, and very cheap poison, used extensively in rat baits. Its action on rodents is variable and uncertain. It often causes vomiting, and small doses

tend to cause immunity. Although it is almost tasteless, ground squirrels and chipmunks refuse to eat it except when their natural food is very scarce, and then strychnine also would be eaten and would be much more effective. During the spring and summer of 1911 the author tried arsenic thoroughly and was forced to the conclusion that it is not a satisfactory poison for any of the rodents mentioned herein, except woodchucks and possibly wood rats.

Potassium cyanide is an exceedingly deadly and dangerous poison, which has been much used to destroy ground squirrels and prairie dogs. Although cheap, it absorbs moisture and quickly decomposes when exposed to the air, and is therefore unsatisfactory. It is not recommended.

Corrosive sublimate, barium carbonate, squill, and nux vomica each have such serious faults that they are not at present recommended.

METHODS OF USING STRYCHNINE.

Three methods of applying strychnine to baits are recommended in this bulletin. In one the food is soaked in a solution of sulphate of strychnine, in another it is coated with starch or flour paste containing powdered alkaloid of strychnine, and in the third it is mixed with starch containing the alkaloid and is then compressed into squares or "biscuits."

Grain soaked in sulphate solution is very bitter and is not recommended except when the bait is to be soaked in tallow to render it waterproof. A sulphate solution is valuable in preparing baits for rabbits and meadow mice.

Starch or flour paste containing powdered alkaloid is recommended, because baits coated with these materials can be prepared much more easily than those soaked in sulphate solution, because animals carrying coated baits are often killed simply by the absorption of part of the poison directly into the blood through the mucous membranes of the mouth or cheek pouches, and because the centers of kernels of coated grain remain sweet and are more freely eaten than those made bitter all through by soaking in sulphate solution.

It is sometimes necessary to take special precautions to avoid killing birds, and in such cases "oatmeal biscuits" are recommended.

NECESSITY OF SPRING POISONING.

Ground squirrels, chipmunks, and mice usually refuse to take poisoned baits when natural food is abundant, and preparations which are effective at one time of the year are often of no use at another. The best time to use poison is in early spring, and the work should be done then if possible. Columbian ground squirrels can not be successfully poisoned at any other season. Thus, although 27 dead

ground squirrels, chipmunks, and mice (fig. 1) were found from 1½ pints (7 cents' worth) of poisoned grain placed early in the season, no dead animals were found from 5 bushels of the same preparations put out after seeds and berries became abundant.

COOPERATION IN RODENT POISONING.

One of the most serious difficulties encountered in a campaign against rodents or other pests lies in the refusal of a certain proportion of the people in most communities to take part in such work. The lands of these individuals then serve as breeding grounds from which the surrounding areas are constantly restocked. For this reason at the outset of such a campaign every effort should be made to

FIG. 1.—Twenty-seven ground squirrels, chipmunks, and mice killed by 7 cents worth of poisoned grain.

secure the cooperation of the entire community. It will greatly aid in a campaign against rodents to have the poison bought in quantity and the poisoned preparations made in large amounts at a central point, whence the people taking part may secure it at cost. If each individual made his own poisoned material, it would be a complicated and unduly expensive process for small ranchers. The convenience of being able to get the prepared poison in small quantities would greatly encourage small proprietors to take an active part in the work. This is proved by the fact that every year thousands of dollars are spent for inferior and disproportionately expensive proprietary poisons simply because they can be easily obtained. One Montana orchard company last year bought 189 pounds of a certain

proprietary squirrel poison at a net cost of 23 cents a pound. In this bulletin a much more effective preparation costing not more than 12 or 15 cents a pound is recommended. Another advantage of cooperation is in the purchase of material at wholesale prices. Thus, while drug stores retail strychnine at from $1.50 to $2 an ounce, it may be bought in quantities of 5 ounces or more at from 60 to 65 cents an ounce.

It is recommended therefore that, whenever possible, standard poisons be mixed in quantity by State experiment stations, counties, commercial clubs, granges, or other associations and then distributed at cost price to the large number of individuals who would thus be in-

FIG. 2.—Columbian ground squirrel.

duced to use them. In the Bitterroot Valley a part of the spotted-fever fund appropriated by the State might well be used for this purpose.

COLUMBIAN GROUND SQUIRRELS.

DISTRIBUTION.

The Columbian ground squirrel (fig. 2), known also as picket pin and gopher, is by far the most important rodent in western Montana in its relations both to agriculture and to spotted fever. It occurs also in northern Idaho, northeastern Oregon, eastern Washington, and the mountains of southwestern Alberta and southeastern British Columbia.

AS TICK HOSTS.

The Columbian ground squirrel is undoubtedly the most important host of the two younger stages of the fever tick, and is almost

always infested with ticks when occurring in suitable country. From the 341 specimens examined by Mr. W. V. King and myself in the course of these investigations 841 seed and 1,234 nymphal wood ticks were taken, an average of 6.09 for each animal. It can readily be seen, therefore, that in fever-infested localities the destruction of this most important host of young wood ticks must be an important supplementary part of any campaign for the control of the disease.

HIBERNATION AND BREEDING.

Although the habits of this ground squirrel vary considerably with climate and locality, in the warmer valleys it usually emerges from hibernation during the latter part of March. It begins rutting about a week or 10 days later and, as the gestation period is about 28 days, the young (averaging about 4 to 5 in a litter) are born in early May. At first they are blind, naked, and helpless. In about three weeks, however, they come to the surface of the ground for the first time and at once begin to eat various sorts of green food. Of 21 young squirrels weighed between June 6 and 12, 1911, about a week after their first appearance, the lightest tipped the scales at 2.75 ounces and the heaviest at 8 ounces. Eleven killed on June 10 averaged 3.75 ounces. The lightest of 30 adults weighed between May 30 and August 15 was 11 ounces and the heaviest 26 ounces, the average being 17.5 ounces.

By about June 1 the old males have begun to recover from the strain of the rutting season and by the middle of July most of them are very fat. From then until they enter hibernation they remain close to their burrows and do little but sun themselves and eat. The old females do not begin to put on fat until about the middle of July and do not become so fat as the males until just before hibernating, if at all.

In most parts of western Montana the Columbian ground squirrels enter hibernation about the middle of August. In the colder parts, however, where they do not emerge from hibernation until the latter part of April, they remain active a full month longer; and at Almota, Wash., they "hole up" in July, having put in an appearance early in February. Thus it appears that the time they enter hibernation is usually about four and a half or five months after they emerge in the spring.

FOOD HABITS.

The Columbian squirrel, more than most other ground squirrels, prefers tender green vegetation to ripe seeds and grains. Probably as a result of these food habits its cheek pouches are small and little used. Among the green foods most attractive to these squirrels are dandelion heads, clover, alfalfa, timothy, lettuce, strawberries and various other berries, young carrots, bean and pea vines, and grow-

ing grain. Oats (whole, hulled, or rolled) are preferred to any other grain; and wheat, though not so well liked, is readily eaten. Barley and rye are seldom taken.

INJURY TO CROPS.

Although ground squirrels are not so serious a pest in Montana as in some other States, the damage they do in many localities is sufficient to warrant their destruction.

Growing grain is eaten by ground squirrels from the time it first appears above ground until the animals enter hibernation. (Fig. 3.) I have seen many wheat and oat fields which were seriously damaged by ground squirrels; and it is safe to say that every one of these animals in a grainfield annually causes at least a dollar's loss. This great damage is well illustrated by the experience of a rancher near Pullman, Wash. In the spring of 1910 he bought 1,000 traps and

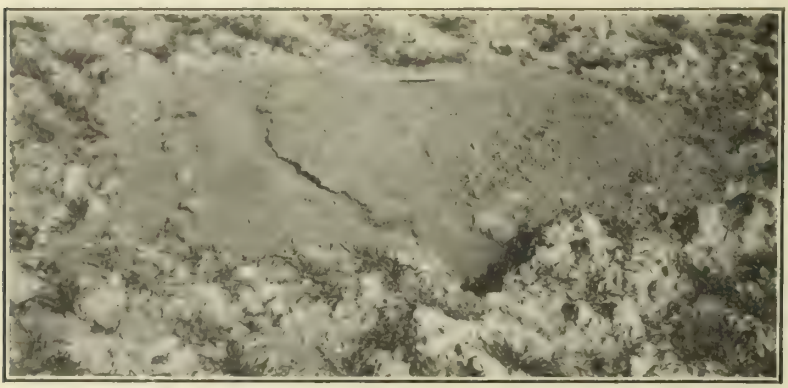

FIG. 3.—Columbian ground squirrel burrow in wheat field.

started to clear the squirrels off his whole ranch. Included in the land on which the animals were exterminated was an 80-acre piece from which the owner had for six years been unable to secure a crop, but after the squirrels were killed off this piece yielded an average of 35 bushels of wheat to the acre.

Carrots, potatoes, beans, peas, and other garden truck are often seriously damaged. Figure 4 shows squirrel work in a carrot field near Florence, Mont. The manager of one of the orchard companies southwest of the same town reported that in 1910 ground squirrels caused the company a total loss of 5 acres of beans, the plants being attacked from the time they sprouted until the pods were formed.

In hayfields squirrels cause serious loss both by eating hay and by covering considerable areas with their mounds, which are a great annoyance when the fields are mowed.

In orchards the most serious damage is usually done to the irrigation systems; but Mr. Moody, president of the Como Orchard Land

Co., of Hamilton, Mont., reports that the depredations on that company's lands assumed a very unusual and serious nature, for the squirrels attacked the buds of the trees themselves and actually

FIG. 4.—Carrots ruined by Columbian ground squirrels.

killed about 45,000 trees in one year. This company at once took systematic steps to destroy the animals on their land, and spent over $1,700 for the work in 1910 and 1911.

FIG. 5.—Washout caused by burrow of Columbian ground squirrel.

Ground squirrel holes are a serious menace to the safety of irrigation systems. Figure 5 shows a washout on a side hill, caused by irrigation water escaping through a squirrel burrow from an

orchard on top of the bench. The chief engineer of the Bitterroot Valley Irrigation Co. writes that in 1911 $184.75 was spent to protect the company's main irrigation ditch and that each of the numerous development camps waged its own war against the squirrels.

POISONING COLUMBIAN GROUND SQUIRRELS.

The Columbian ground squirrels are probably the most difficult of the native rodents to poison. The chief reasons for this are that the animals prefer green vegetation to grain, that they do not store food, that they have an intense dislike for bitterness, and that they for some cause refuse to eat arsenic baits. For these reasons several years of experimenting have failed to produce a bait which is effective on the Columbian ground squirrels when green vegetation is abundant. But the work done during 1911 indicates that these animals can be successfully poisoned if the poison is placed early in the spring when they first come out of hibernation. This means that the baits must usually be put out not later than the 1st of April and that they will not succeed after vegetation is well started.

Hulled oats (or "groats," as they are technically known) are preferred by these squirrels to all other forms of grain and are much better than wheat for use in poisoning. Groats can be secured at oatmeal mills, usually at a cost of about 3 or 4 cents a pound. Ordinarily in the process of manufacture the groats are raised to a high temperature in coffee roasters, but the unroasted grain is better for squirrel bait, and should be secured where possible. Although hulled oats are more expensive than wheat, they should nevertheless be used, for they will give better results. Individual ranchmen making up small quantities of poison are likely to have difficulty in securing groats—another argument in favor of the wholesale manufacture and retailing of squirrel poison by associations.

Care should always be taken to avoid poisoning useful birds, and in some cases a special "bird-proof" preparation is necessary. The poison which best meets these requirements is a small square "biscuit" of poisoned material, which when dry is too hard for small birds to peck to pieces and too large for them to swallow whole. These baits require considerable time to prepare, and therefore cost more than poisoned grain; but they are effective and are the only baits which will not endanger birds. They are, moreover, more resistant to rain than loose grain.

The following preparations are recommended, but must be used early in the spring:

FORMULA I. POISONED GROATS.

Hulled oats ("groats")	4 quarts.
Strychnine alkaloid (powdered)	½ ounce
Flour	5 level tablespoonfuls.
Cold water	1 cup.

Place the flour in a bowl and add one-third cup of cold water, stirring until no lumps remain. Then stir in the other two-thirds cup of cold water and heat to boiling point over a slow fire, stirring constantly. Remove the paste from the stove, mix in the powdered strychnine alkaloid, and pour the poisoned paste over the groats, mixing until every kernel is evenly coated. Spread and dry the poison, and it may be either used at once or kept indefinitely. A galvanized iron washtub is an excellent receptacle in which to mix poisons. A heavy round-bottomed china or earthen cup and a round-headed iron bolt about 5 inches long make a good substitute for mortar and pestle with which to powder strychnine crystals.

The addition of a quarter ounce of powdered dry extract of licorice and 2 teaspoonfuls of strawberry or raspberry sirup (such as is used at soda fountains) will aid to disguise the bitterness of the strychnine and will improve the taste of the bait, but these two ingredients are not necessary.

Poisoned wheat may be prepared in the same way, except that only two-thirds as much flour paste is needed, for the glossy outer coating of the kernels does not absorb moisture as readily as do groats.

FORMULA II. POISONED BISCUITS.

Oatmeal (rolled oats)	4 quarts.
Strychnine alkaloid (powdered)	½ ounce.
Gloss starch	2½ heaping tablespoonfuls.
Water	1 quart.

Stir the starch, dissolved in one-half cup of cold water, into 1¾ pints of boiling water, thus making a smooth paste of medium thickness, and into this stir the powdered strychnine. Then mix it thoroughly with the oatmeal, forming a stiff dough. Press this dough into sheets one-fourth inch thick and cut it into one-half inch squares. After these have been dried in the sun—not in an oven—they will become hard and will keep indefinitely. This formula should make about 3,000 or 3,500 biscuits, each of which will contain enough poison to kill a squirrel. A little crushed starch or flour will prevent the dough from sticking to hands and utensils. In preparing small quantities of biscuits a flat board may be used to press the dough into sheets and a knife to cut it into squares. But where the baits are to be manufactured in bulk a rotary confectioner's or druggist's cutter will facilitate the work.

PUTTING OUT THE POISON.

A teaspoonful of loose grain, or two of the poisoned biscuits, should be placed at the entrance of each occupied squirrel hole. It will thus be more available for the squirrels and less likely to attract the attention of birds than if scattered broadcast. Poisoned baits

should never be placed in ground-squirrel holes, for when so placed they are trampled into the dirt and are not eaten. When stock is ranging in the poisoned territory the grains may be scattered a little, not too much.

TRAPPING.

Next to poison, traps are the most effective means of destroying the Columbian ground squirrel. In fact, only by their use can the animals be exterminated in a given locality, for there are always some individuals which refuse to take poisoned baits or which escape fumigation. But since trapping is more expensive than poisoning, the two methods should be combined, as many as possible of the animals being killed with strychnine and the rest caught with traps. Systematic trapping has not, in most localities, been as much resorted to as it should have been. It can not be too strongly recommended as a supplement to poison.

The value of systematic trapping is well proved by the results which have attended its use in the rolling wheat lands of Whitman County, Wash., where it has steadily advanced in favor and has now largely supplanted poisoning. One or two of the ranch owners are operating 2,000 or more traps, and a number are using from 500 to 1,000.

Mr. Mert Davis, of Pullman, is more than anyone else responsible for the introduction of systematic squirrel trapping, and his experience is valuable. Two years ago he began trapping on a newly purchased ranch of 100 acres, all of which was very badly infested with squirrels. During the season of 1909 he used 1,200 traps, continuing the work through 1910 and into the spring of 1911, when only a few scattered squirrels remained; and these were secured soon afterwards. This ranch is now entirely free from squirrels, and, although the surrounding fields have not been trapped, is protected from invasion by keeping traps in the holes around the boundaries. Mr. Davis believes that old rusty traps are at least as good as shiny new ones. The squirrels caught were chopped up and fed to the chickens.

METHODS OF SETTING TRAPS.

There are two methods of setting squirrel traps, the "hole set" and the "surface set."

The hole sets are the ones almost universally employed at present. In this method jump traps, or ordinary steel traps (No. 1 are better than No. 0), are set in every hole. (Fig. 6.) If these traps are tended every day, all the squirrels are sure to be caught. The principal objection to this method is the very large number of traps required, for since there are often ten or fifteen times as many holes as there are squirrels a large number of traps often cover surprisingly little ground. Mr. Claude Haines, a Whitman County rancher, bought

and operated 1,000 traps in 1911. He used 4-foot trap stakes split from waste fence posts, but believes that half laths would be cheaper

FIG. 6.—"Hole set," made with ordinary outside-spring steel trap.

and fully as good. (Fig. 7.) He and another man worked one and three-quarter days staking and setting the 1,000 traps the first time, but on another occasion Mr. Haines alone set 500 traps in a day and

FIG. 7.—Four-foot cedar trap stakes at burrows of Columbian ground squirrels.

himself tended the whole 1,000 traps. He used nothing but hole sets. One of the unfortunate features of this method of setting traps is that weasels or other squirrel enemies are sure to be caught.

Surface sets are made by sinking traps flush with the surface of the ground near squirrel burrows and sprinkling oats or other bait in a circle just outside of the jaws. (Figs. 8 and 9). The advantages of this method of setting are that fewer traps are required to cover a given number of burrows and that enemies of squirrels using the burrows are not endangered. The disadvantages are that the surface sets require more time to make, that they occasionally catch meadow larks, quail, or other valuable birds, and that they are not always effective when green vegetation is abundant. "Jump" traps with their large pans are better suited to surface sets than are the small-panned outside-spring traps, for the animals are likely to walk around the latter sort of traps instead of stepping into them. Sometimes clods of earth placed on opposite sides of the traps serve to guide the squirrels into them.

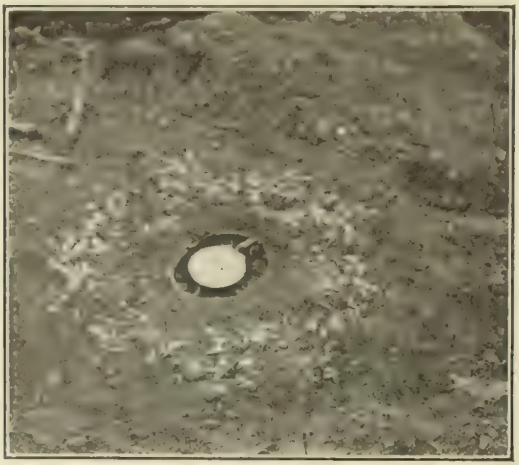

FIG. 8.—"Surface set," made with "jump" steel trap.

FIG. 9.—Two Columbian ground squirrels caught in a "surface-set" jump trap.

The most effective trapping can be done by using a combination of hole and surface sets made as circumstances suggest, and with jump traps, perhaps one-third of which are No. 1 and the rest No. 0. In this case the No. 1 traps should be reserved for the surface sets and the smaller size used in the holes. As a rule waste land, where burrows are numerous, can be trapped to the best advantage with surface sets, while hole sets are more effective in

cultivated areas, where each squirrel has but a few holes. Traps should be visited at least once a day, in order both to secure the best results and to avoid causing imprisoned animals unnecessary suffering. Figure 10 illustrates one way of handling a considerable number of traps.

Ordinary No. 1 steel traps cost about $125 to $130 a thousand and "jump" traps are slightly more expensive.

FUMIGATION.

Fumigation with carbon bisulphid is very effective when employed early in the season while the ground is still damp. Dry ground

FIG. 10.—A convenient method of carrying 200 traps and stakes.

rapidly absorbs the fumes. Crude carbon bisulphid suitable for this purpose costs from 8 to 10 cents per pound in 50-pound carboys or drums. Since it is a volatile liquid and rapidly loses strength on exposure to the air, it should be kept in tightly corked bottles or cans.

When bisulphid is used to fumigate squirrel burrows, about a tablespoonful should be poured on a piece of loosely rolled cotton or other absorptive material and pushed as far as possible down the burrow, the opening to which should then be immediately closed. Every hole should be treated, and in case of outlying burrows a little larger amount of the bisulphid should be used. As carbon bisulphid is inflammable and the fumes highly explosive, it should never be

opened near a fire or where a person is smoking. Figure 11 shows an excellent outfit for using bisulphid.

CONCLUSIONS.

The Columbian ground squirrel is the worst rodent pest in western Montana, and is of especial importance in regions infested with spotted fever, where it is the principal host of the younger stages of the "fever tick," or wood tick. It is also the most difficult rodent in the Northwest to control. The methods of eradication recommended are early spring poisoning, followed at once by the systematic use of traps or carbon bisulphid.

FIG. 11.—Outfit for use in bisulphiding ground-squirrel burrows.

CHIPMUNKS.

DISTRIBUTION.

Several kinds of chipmunks occur in western Montana, but they are so nearly alike in appearance and habits that for the purposes of this work no distinction is made between them. (Fig. 12.) Although chipmunks are not nearly so important as are Columbian ground squirrels, they have a very definite relation both to agriculture and to spotted fever.

AS TICK HOSTS.

Probably more young wood ticks feed on chipmunks than on any other kind of animal except Columbian ground squirrels. Of about 190 examined during 1910 and 1911, many were found to be tick infested and some carried 50 or more seeds or nymphs. Chipmunks occur commonly around unoccupied log cabins, in stone and rail fences, and in pastures where there is more or less brush and fallen

timber, and in this way come into close contact with man and with domestic animals. When young ticks dropped by chipmunks around

FIG. 12.—Yellow-bellied chipmunk.

ranches molt and emerge as adult "wood ticks" they have a good chance to become attached to persons or domestic stock. It is there-

FIG. 13.—Chipmunk damage in wheat field.

fore especially important that in any campaign against spotted fever an effort be made to kill off the chipmunks around ranches.

INJURY TO CROPS.

Although chipmunks occasionally do much damage to peas, strawberries, or other such crops, they are chiefly harmful in wheat fields, where they cut the heads from the grain, usually after the kernels are in the dough stage. Often the animals start to climb the stalk, bend it down, cut off the head, carry it to a near-by stump or fence, and there hull and eat it. (Fig. 13.) Very frequently, however, they do not content themselves with this rather slow method, but break down stalk after stalk, taking only a few kernels from each. A field in which chipmunks adopt these tactics is soon seriously damaged by the bending and matting together of the stalks. Such a field can easily be distinguished from one injured by ground squirrels, which eat off the stalks rather close to the ground. The wheat fields in

FIG. 14.—Seed spot of pine seeds pillaged by chipmunks.

narrow valleys and on benches near the timber are likely to suffer most severely from the depredations of these animals.

Chipmunks and mice are both very fond of the seeds of pines, firs, and other forest trees, and it is absolutely essential that areas which are to be replanted be rid of these animals. Figure 14 shows a seed spot dug out by chipmunks on the Cabinet National Forest. One chipmunk has been seen to visit 38 seed spots in four minutes.

POISONING CHIPMUNKS.

Although chipmunks are not so hard to control as are Columbian ground squirrels, they have the same dislike for the intensely bitter taste of strychnine baits, and must therefore be poisoned in the spring

or early summer, before the seeds and berries which form their favorite food have ripened. Since wheat is liked by chipmunks better than any other grain, it forms the best medium for the administration of poison. Dried currants are relished even better than wheat and make an excellent bait when treated with the flour coating described below. When a waterproof poison is desired, the tallowed wheat recommended in Formula IV will give good results. To be effective these poisons must be placed in the spring or early summer. If grainfields are to be protected, a strip of adjoining country must be poisoned before the grain begins to head.

FORMULA III. FLOUR-COATED WHEAT.

Wheat	20 quarts.
Strychnine alkaloid (powdered)	1 ounce.
Flour	¾ cup.
Water	1 quart.

Mix the flour with a cup of cold water to form a thick, smooth paste, and then stir in the remaining 1½ pints of cold water. Heat to boiling point over a slow fire, stirring constantly. Then remove from the stove, mix in powdered strychnine alkaloid, and mix with the wheat until every kernel is evenly coated. Spread and dry the preparation, and it may either be used at once or kept indefinitely.

Although alkaloid of strychnine is here recommended, because it is less quickly bitter than sulphate, the latter may be used if the former can not be secured. The addition of one-half ounce of powdered dry extract of licorice and 1½ tablespoonfuls of strawberry or raspberry sirup to the hot starch coating will make the baits more acceptable, but these materials are not necessary.

FORMULA IV. WATERPROOF WHEAT POISON.

Wheat	16 quarts.
Strychnine sulphate	1 ounce.
Water	1 gallon.

Dissolve the strychnine in 1 gallon of boiling water and pour it over the wheat, stirring until all the kernels are well wetted, then mixing it occasionally so that the moisture will be evenly distributed. After allowing the grain to stand for 12 or more hours, until it has absorbed all the water, place it in trays and dry it in the sun, not in an oven. Then return it to the mixing vessel, add 1 pint of melted mutton or beef tallow, and cook for about 25 minutes over a hot stove, stirring constantly. The poison is then ready for immediate use, or can be kept in a dry place as long as desired. The advantage of this preparation is that it is waterproof and will withstand heavy rains.

OTHER METHODS OF DESTROYING CHIPMUNKS.

If it becomes necessary to protect small areas from chipmunks after the animals can obtain such an abundance of seeds and berries

that they refuse to take poison, they can best be shot or caught in steel traps or rat traps baited with bacon, grain, or other attractive food. But these makeshift methods of destruction are expensive, and the far-sighted man will destroy the chipmunks while poison is still effective.

CONCLUSIONS.

Chipmunks should be destroyed in this region, because they both damage crops and harbor young fever ticks. This may best be accomplished by the use of strychnine in flour-coated or tallow-coated wheat, but may be done at greater expense with the aid of guns and traps.

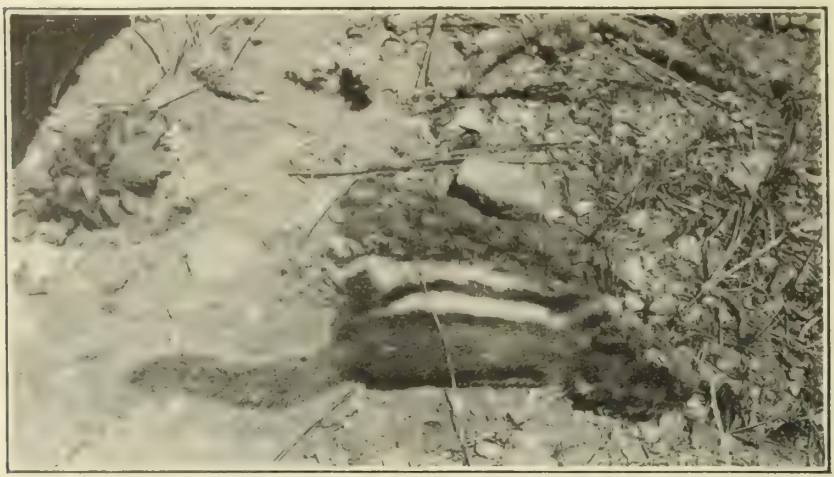

FIG. 15.—Side-striped ground squirrel killed by carrying poisoned grain in cheek pouches.

SIDE-STRIPED GROUND SQUIRRELS.

Side-striped ground squirrels (fig. 15), known also as rock squirrels, tiger squirrels, and two-striped chipmunks, occur throughout much of the rocky, timbered country of western Montana.

AS TICK HOSTS.

These striped ground squirrels are less important tick hosts than chipmunks only because they are not so generally distributed. Since they are very often infested with young fever ticks and have the chipmunks' habit of frequenting temporarily unoccupied log cabins, it is very important that war be waged against them in fever-infested localities. Young fever ticks were taken from more than half of those shot during these investigations, 45 being found on a single animal.

INJURY TO CROPS.

Side-striped ground squirrels damage crops in the same way as chipmunks, but their larger size and immense cheek pouches enable each animal to do a much greater amount of injury. One shot as it left a stable was found to be carrying 357 kernels of whole oats in its cheek pouches. (Fig. 16.)

HABITS.

These animals are true ground squirrels, as distinguished from chipmunks, and hibernate during the winter. In western Montana they usually "hole up" in September and reappear in March.

FIG. 16.—Dissection showing 357 kernels of whole oats in cheek pouches of side-striped ground squirrel.

In food habits the striped ground squirrel is intermediate between the Columbian squirrel and the chipmunk, for although it eats green vegetation freely, it is especially fond of seeds, grain, and berries. Unlike its bigger relative, it has immense cheek pouches and habitually carries food in them.

Probably this animal raises but one litter of young a year. The young, averaging about four to the litter, appear above ground during the latter part of May or early June.

POISONING SIDE-STRIPED GROUND SQUIRRELS.

Owing to the fact that these squirrels habitually carry food in their cheek pouches, they are very easily poisoned by baits coated

with strychnine held in flour paste. When such baits are pouched the coating is dissolved by the mouth juices and the strychnine set free and then absorbed through the lining of the pouches directly into the blood. Very few of these animals poisoned by the writer have eaten any of the bait, practically all having been killed directly through the cheek pouches.

The baits recommended for chipmunks (Formulas III and IV) are both very effective against side-striped ground squirrels.

PINE SQUIRRELS.

INJURY TO CROPS.

Although pine squirrels (fig. 17) are abundant throughout the coniferous timber of western Montana, they do not as a rule cause

FIG. 17.—Young pine squirrel.

any serious loss of crops. After the extensive forest fires of 1910, however, they attacked many of the apple orchards situated near the foothills along the edges of the Bitterroot Valley, doing considerable damage in some of them. A rancher living near Florence reported that his two boys shot 200 pine squirrels from the trees in a 5-acre apple orchard. So far as the author has been able to find out, these animals have never before seriously damaged apples in the Bitterroot, and it seems probable that they were driven to do so in the fall of 1910 by the unusual scarcity of their natural food, resulting from the great fires of late summer. Up to the 1st of September no damage of this sort was reported in 1911.

A less important sort of damage for which pine squirrels are responsible is the cutting off of the tips of numerous pine boughs. In thick stands of timber this damage is unimportant, but solitary trees are often seriously injured.

PINE SQUIRRELS AS TICK HOSTS.

Pine squirrels living in good "tick country" are almost always infested with young wood ticks, as many as 50 having been found on a single animal. It is therefore important that in fever districts these squirrels be destroyed, at least around ranches.

DESTRUCTION OF PINE SQUIRRELS.

As a rule, pine squirrels can easily be killed off by shooting; and they are readily caught in rat or steel traps baited with prunes, raisins, or pork. They are rather difficult to poison, but the strychnine "biscuits" recommended in Formula II should prove an effective pine-squirrel poison if used early in spring.

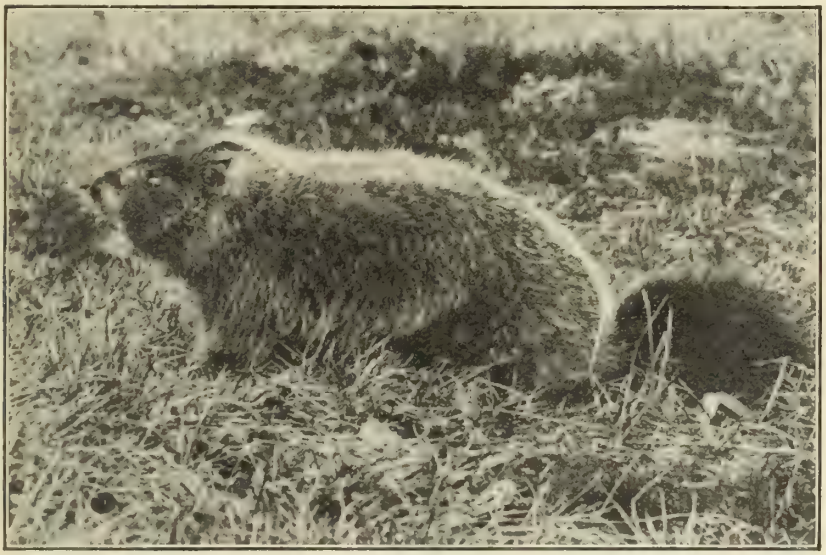

FIG. 18.—Woodchuck, which injures crops and spreads spotted fever.

WOODCHUCKS.

DISTRIBUTION.

Woodchucks (fig. 18), sometimes called "ground hogs," are locally abundant in rocky situations along the edges of valleys in many parts of western Montana. In the Bitterroot Valley they are especially numerous in rock piles and around abandoned buildings along the valley's edge. From one rock pile in a timothy field I took 15 woodchucks in 1910 and as many more in 1911; from under the buildings of an unoccupied ranch at least a dozen were secured during these two seasons, and in the stone wall surrounding a neglected orchard I estimated that there were at least 30 adult woodchucks.

HIBERNATION, BREEDING, AND FOOD.

Like the Columbian ground squirrel, woodchucks "hole up" in August and hibernate until the following March. The young, usually five in a litter, are born during the latter part of April and are out in full force and shifting for themselves by early June.

Woodchucks live almost entirely on green vegetation. Timothy, clover, alfalfa, dandelions, and numerous native plants are favorite foods.

INJURY TO CROPS.

Woodchucks are a serious nuisance wherever they occur near cultivated land. In hayfields they consume a very considerable amount of feed; and beans, carrots, potato vines, cabbage, and other garden truck are almost sure to suffer whenever woodchucks have access to them.

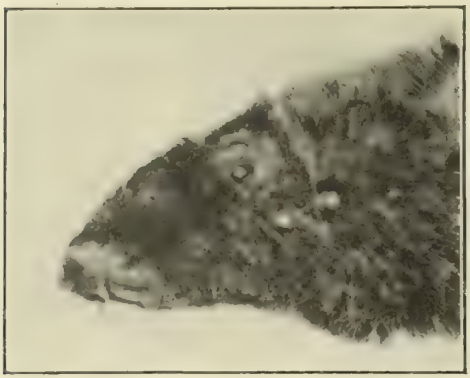

FIG. 19.—Partly engorged adult wood ticks on woodchuck.

WOODCHUCKS AS TICK HOSTS.

The woodchuck is of especial importance as a tick host, for it is one of the few native rodents on which the adult wood ticks feed until full of blood and ready to develop eggs. (Fig. 19.) It is also a favorite host of the seed and nymphal ticks, over 200 having been taken from one woodchuck. Moreover, this animal, when in captivity, is known to be susceptible to spotted fever, and there seems little reason to doubt that it is one of the species which helps to keep the disease alive. It is evident, therefore, that any campaign to eradicate ticks and control spotted fever should include an effort to lessen the number of woodchucks near cultivated land and pastures.

POISONING WOODCHUCKS.

A very inexpensive and effective woodchuck poison may be made by simply coating dandelion heads, clover, or alfalfa with thin starch or flour paste poisoned with powdered white arsenic, 2 gallons of the fresh green food being coated with a pint of cold flour paste containing 3 ounces of arsenic. As such a preparation both sours and wilts quickly, it should be mixed in the afternoon and in the evening placed at the entrances to woodchuck burrows, so as to be available when the animals first come out next morning. By one

treatment with this poison the author killed all the woodchucks living under a shanty in a field where timothy and other green food were abundant.

TRAPPING WOODCHUCKS.

Although young woodchucks usually do not hesitate to step into exposed steel traps, older animals are more cautious. For this reason it is best to conceal the traps, covering them with paper and dust or with dry grass. If the traps are carefully set at the mouths of burrows, no bait is needed. Since woodchucks often spring traps with their breasts or bellies, and since their legs are short and slippery, it is better to use a rather large-sized trap. The number 1½ "jump" traps have been found excellent for this purpose.

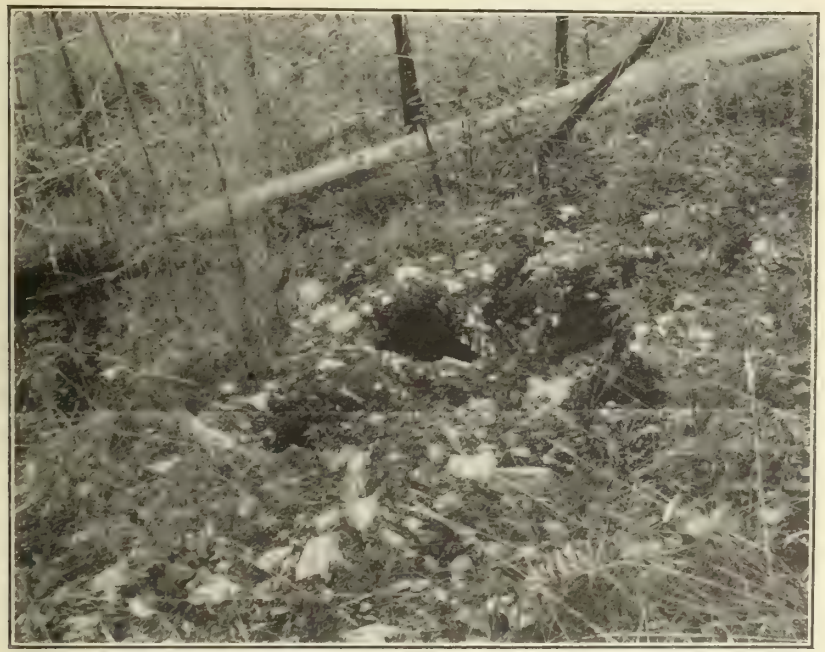

FIG. 20.—Mouse refuge in holes left by burned stump and roots.

WHITE-FOOTED MICE.

DISTRIBUTION AND HABITS.

The white-footed mouse is probably the most generally distributed rodent in western Montana. It lives in every sort of country—under fallen logs, on sage-covered benches, on pine-covered slopes, in houses and stables, in dense forests, in grainfields, in damp meadows, and in dry fields. (Fig. 20.) The mice do not hibernate and are active even during the coldest nights in midwinter. They raise several litters of young each year, the average number in each being four or five.

They live principally on seeds, berries, and grain, and lay up quantities of food for the winter. Owing to their abundance they destroy considerable quantities of grain and berries, often carrying off and storing more than they eat on the spot. (Fig. 21.) They do great damage in nurseries and on forest sowing areas, where they dig up and destroy the seeds, this damage being so serious that no sowing can be successful where they are plentiful.

They are frequent hosts of young wood ticks and are of especial importance in fever districts because they frequently live in occupied houses and may thus be the means of bringing infected ticks into contact with man.

FIG. 21.—White-footed mouse killed by carrying 17 kernels of poisoned wheat.

POISONING WHITE-FOOTED MICE.

In most localities white-footed mice take poison readily and are easily killed by any of the baits recommended for chipmunks or ground squirrels. (See Formulas I to IV.) The poisoning must be done, however, in the spring or early summer, for after the various native seeds and berries ripen, the mice begin to store away their winter food, and poisoned baits are simply stored, not eaten. Thus while 13 dead mice have been found from a couple of dozen poison baits placed early in the summer, 5 bushels of poisoned wheat have been carried off by the animals in October without materially lessening their numbers. It is therefore evident that, though white-footed mice are easily killed in the spring and early summer, poisoning done after the native seeds and berries ripen is likely to be wholly useless.

HOUSE MICE.

These little gray mice, with their long hairless tails and small ears, are native to eastern Asia, but have been introduced by man into most civilized parts of the world. In Montana they are abundant in most of the large towns and are to be found on some of the outlying ranches. Although no ticks have been found on the few house mice examined, it is probable that these animals do occasionally serve as tick hosts, for they frequently live in infested fields.

Though not quite so easily poisoned as the native mice, they may usually be killed by either of the forms of poisoned grains recom-

mended for chipmunks. (Formula III or IV.) Owing to the fact that house mice are sometimes able to eat out the centers of poison-coated kernels of wheat or groats, the tallowed grain described in Formula IV is best suited for poisoning them.

WOOD RATS.

Wood rats (fig. 22), called also pack rats and mountain rats, occur in the mountains and along the edges of valleys throughout western Montana. They are active only at night and do not hibernate. They are especially fond of tender green vegetation and berries, but readily eat seeds, grain, and table scraps.

AS TICK HOSTS.

Wood rats living in "tick country" are usually infested with young wood ticks; and this fact is especially important because

FIG. 22.—Young wood rat.

infested animals often live in temporarily unoccupied dwellings. Two shot in one of the buildings of an abandoned railroad construction camp were fairly covered with seed and nymphal fever ticks, there being at least 100 on them. Many of these young ticks would have developed into adults in the buildings where the rats were killed; and, if one or both of the rats had had the spotted fever, it is quite possible that any person moving into the house might have contracted the disease.

DESTROYING WOOD RATS.

Wood rats do not readily eat loose poisoned grain but can probably be effectively poisoned with "biscuits" made as described in Formula II, though only about half as much strychnine (1 ounce to 16 quarts of grain) is required for these animals.

A number of wood rats had been living for several years in the house mentioned in the woodchuck poisoning experiment described

on pages 28–29, but after the treatment with arsenic-coated dandelion and clover heads not a single rat could be found. Although this is the only time the author has tried arsenic as a wood-rat poison, he believes that this inexpensive preparation will prove effective against the animals. Wood rats are easily caught in ordinary rat traps baited with prunes, raisins, or oatmeal.

MEADOW MICE.

DISTRIBUTION AND HABITS.

Three kinds of meadow mice occur in the valleys of western Montana, and another lives high up in the mountains; but since all three of the valley species may sometimes be found in the same hayfield,

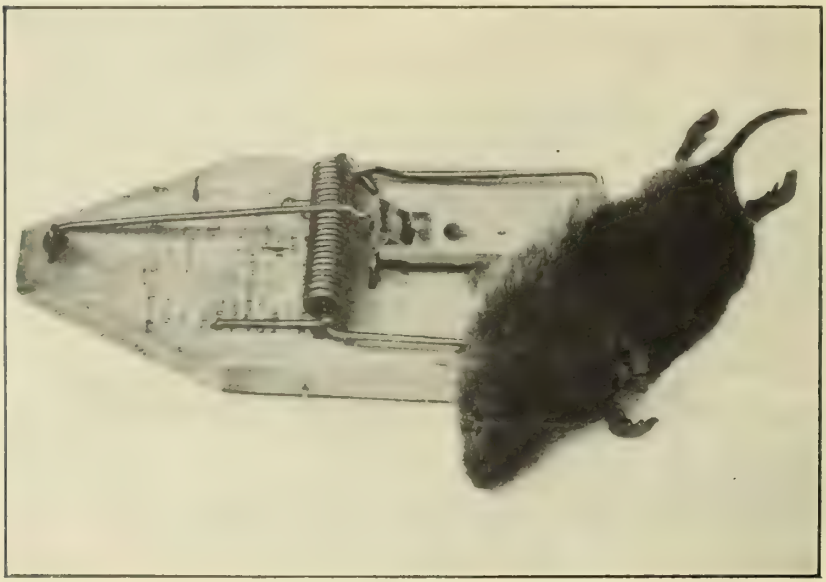

FIG. 23.—Meadow mouse caught in unbaited trap.

and since their habits are much alike, it is unnecessary here to distinguish between them. (Fig. 23.)

As a rule these mice occur only in damp fields and meadows where there is an abundance of grass. In such places their runways form networks on the surface of the ground, with occasional burrows leading to underground passages. Their nests are compact masses of dry grass, usually placed in rank vegetation or under fallen logs. Sometimes, however, the mice live underground, often among the roots of rotten stumps. (Figs. 24 and 25.) Several litters of young are born each year, the average number in a litter being six.

INJURY TO CROPS.

Under normal conditions meadow mice in hayfields do not very seriously injure the crop; but their nests are a continual source of an-

noyance when the hay is being cut, for they frequently clog the sickle bar. In cases where the mice suddenly increase enormously in num-

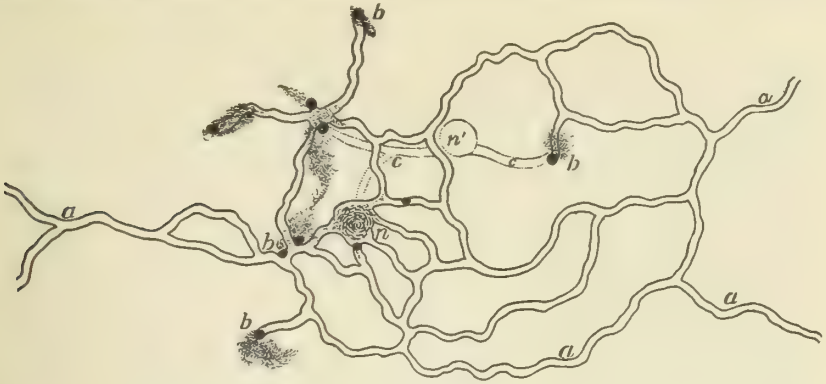

FIG. 24.—Diagram of meadow mouse runway.

bers they may constitute a serious plague, as happened in Nevada in 1907, when they destroyed the alfalfa fields in whole valleys and caused a loss of several hundred thousand dollars. (Fig. 26.) To avoid the possible occurrence of such a plague, careful watch of these mice should be kept and any great increase in their numbers reported at once, so that repressive measures may be promptly taken.

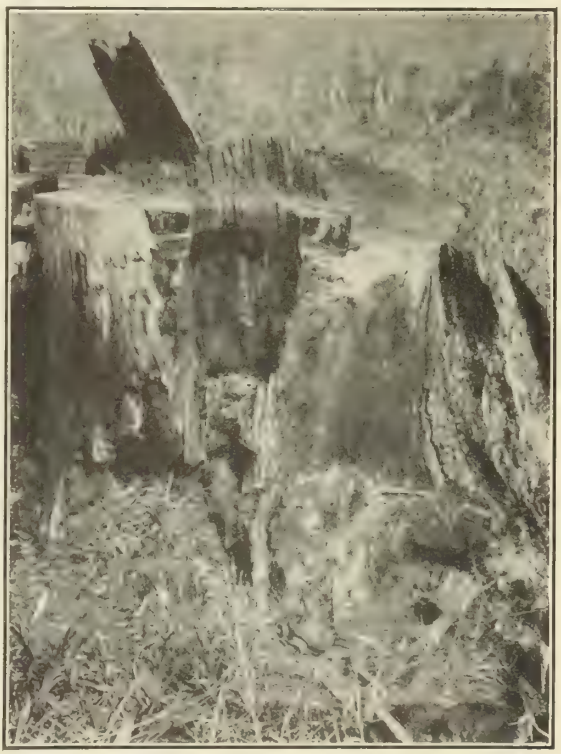

FIG. 25.—Mouse infested stump in hayfield. A favorite shelter for meadow mice.

Probably the most serious damage caused by meadow mice is in neglected orchards, in which rank vegetation affords ample shelter. (Fig. 27.) In one such orchard, containing 10 acres of 10-year-old trees, an examination of 243 trees showed that 32 per cent had been wholly girdled and killed, that 45.8 per cent had been partially girdled but not killed, and that

only 22.2 per cent were uninjured. A rancher living near Florence reports that during one winter the meadow mice killed 175 out of 1,000 five-year-old apple trees and that he has had to fight the mice ever since to keep them from killing more. Blackberry and raspberry bushes, when not kept cleanly cultivated, are often girdled by meadow mice.

POISONING MEADOW MICE.

Although damage to berry bushes and orchard trees can be avoided by clean cultivation, it is at times desirable to poison meadow mice. As these animals are much more fond of oats than of wheat, poisoned hulled oats are best for poisoning them. To be effective the grain preparation must be used early in the spring, as soon as the snow goes off. Groats prepared as recommended in Formula I, with the amount

FIG. 26.—Alfalfa field ruined by meadow mice during Nevada mouse plague of 1907–8.

of strychnine reduced to 1 ounce to 40 quarts, should give excellent results. When groats are not available, crushed wheat may be used. One ounce of strychnine sulphate dissolved in 2 gallons of water should be sprinkled over and thoroughly mixed with the wheat.

The following two preparations were very successfully used during the Nevada mouse plague, and there is every reason to think that they will be of equal value if used in the Northwest.

FORMULA V. GREEN ALFALFA.

Chopped alfalfa or clover	45 pounds.
Strychnine sulphate	1 ounce.
Water	1½ gallons.

Chop young shoots of alfalfa or clover into pieces 2 or 3 inches long. Dissolve the strychnine in half a gallon of hot water and add it to a gallon of cold water. Sprinkle this poisoned solution slowly over the alfalfa, mixing until the moisture is all taken up. Put

Fig. 27.—Apple tree killed by meadow mice.

a few pieces at a place along the mouse runways in the evenings or on cloudy days.

Chopped dry alfalfa or clover hay or the fine material which gathers at the bottoms of stacks and haymows may be used during

the winter instead of green hay, but in this case the following formula should be used:

FORMULA VI. ALFALFA HAY.

Chopped alfalfa (or clover) hay	30 pounds.
Strychnine sulphate	1 ounce.
Water	5 or 6 gallons.

The alfalfa or clover should be green rather than bleached, and chopped stems, rather than the blossoms and leaves, should be used, for they retain moisture longer.

Place the chopped hay in a large galvanized-iron washtub, sprinkle with 3 gallons of fresh water, and mix well with a pitchfork. Dissolve the ounce of strychnine in 2 or 3 gallons of hot water and sprinkle it over the dampened hay, stirring until all the poisoned solution is taken up. The bait is then ready for use. Since this preparation does not keep well, no more should be made up at one time than is needed for immediate use.

POCKET GOPHERS.

DISTRIBUTION AND HABITS.

Pocket gophers are numerous in western Montana, being especially abundant on ranches situated in the bottoms of valleys. (Figs. 28 and 29.)

FIG. 28.—Pocket gopher with pouches full.

They spend practically all their lives in the underground tunnels which they excavate, and are seldom seen except when throwing fresh soil out of their burrows. They are not nocturnal, but are most active in the evenings and early mornings and on damp, cloudy days. The dirt excavated in making the tunnels is thrown out in little piles at irregular intervals, and the holes are then plugged up. (Fig. 30.) It seems probable that pocket gophers breed but once a year, the average number of young being four or five.

INJURY TO CROPS.

Gophers on a ranch are certain to be a more or less serious nuisance, for they injure irrigation systems, kill fruit trees, damage hayfields, and attack potatoes and other garden truck.

In many localities their most serious depredations are in young orchards, where they eat off the roots of trees just below the surface

FIG. 29.—Pocket gopher with pouches turned inside out.

of the ground. (Fig. 31.) This damage is done mainly during the winter months, when green food is scarce, and often the first indication of the gophers' work is the toppling of the trees when the ground thaws in the spring. Apple, pear, and cherry trees are all attacked. A rancher on Lo Lo Creek, where pocket gophers are abundant, reports that in one winter they killed 60 out of 80 three-

FIG. 30.—Double line of gopher hills. The dotted lines indicate position of main tunnel.

year-old pear and cherry trees planted the previous spring, and that they have since destroyed most of the remaining trees.

Although the gophers in hayfields live on roots of plants, the greatest damage is usually caused by the mounds which they throw up. (Fig. 32.) Single mounds sometimes cover a square yard or more of surface, and often whole fields are dotted with them. When the hay is being cut these mounds constantly interfere with the mower and by preventing close mowing cause the loss of much hay.

Gophers sometimes cause serious breaks in the main ditches of irrigation systems, but more often their burrows interfere with the smaller laterals and are thus an annoyance rather than a serious menace. The animals like to work in soft, damp ground, and find soil under the laterals well suited to their wants—with the result that, when water is again turned into these ditches, they are found to be obstructed by the gopher mounds or pierced by their burrows.

FIG. 31.—Stock of apple tree killed by pocket gophers.

Garden truck of various kinds is sometimes attacked by pocket gophers, and potatoes are often seriously damaged. Once while helping a rancher dig potatoes in Sanders County, Mont., the author found that a gopher burrow followed each row and that at least one-fifth of the potatoes had been taken.

POCKET GOPHERS AS TICK HOSTS.

Although one seed wood tick was taken from a pocket gopher secured in August, 1911, gophers so seldom serve as tick hosts and spend

so much of their lives underground that their relation to spotted fever can not be considered of much importance.

POISONING POCKET GOPHERS.

These animals may be readily destroyed by either trapping or poisoning. Until recently the former method was the more effective; but, owing to investigations carried on during the fall of 1910 and spring of 1911 by T. H. Scheffer, of the Biological Survey, an exceedingly satisfactory method of poisoning the animals is now available. The following are Mr. Scheffer's directions for preparing and using the poison:

FIG. 32.—Pocket-gopher mound in wheat field.

FORMULA VII. POISONED VEGETABLES.

Sweet potatoes, parsnips, or carrots	8 quarts.
Medium starch or flour paste, cold	½ pint.
Strychnine alkaloid, powdered	¾ ounce.
Saccharine	1/16 ounce.

Place the vegetables in a wooden pail or tub and with a sharp spade cut them into pieces about half an inch square. (Small quantities may be cut with a knife.) Mix the powdered strychnine into the paste and pour it over the chopped vegetables, stirring them until each piece is coated. Sulphate of strychnine may be used instead of the alkaloid if the latter is not available. If carrots are used the pieces should be spread and the outsides allowed to dry slightly before the starch is applied.

About a tablespoonful of this bait should be placed well down into the main tunnel at one or more points. This is best accomplished by

the aid of a prod made from a hoe or broom handle, dull-pointed at one end and with a 15-inch piece of quarter-inch steel rod inserted in the other. The steel probe is used to locate the plugged-up lateral leading from a fresh mound, or the main tunnel between mounds; and the blunt-pointed end to enlarge the hole thus made. The opening, unless very large, need not be closed. After a runway has been poisoned the mounds along it should be leveled, so that new ones can be readily detected; and if no fresh workings are seen it is safe to conclude that the gopher occupying the run has been killed. With this method from 90 to 100 per cent of the gophers may be killed by a single treatment of the runs.

TRAPPING GOPHERS.

The old-fashioned steel traps are often used to secure pocket gophers, but they are unsatisfactory. If steel traps are to be used, "jump" traps are much the best for gophers. These traps should be set uncovered in the main tunnel, and the openings through which they have been inserted should be so tightly closed that no light can penetrate the run.

Several excellent traps designed especially for pocket gophers have been put on the market. These are set in laterals from which the trapper has removed the earth plug, and are designed to catch and instantly kill the gophers as they attempt to refill the holes. When these traps are used, the openings into the tunnel should not be closed. An old case knife makes an excellent instrument with which to locate and open up the dirt-filled laterals leading from the mounds to the main tunnel.

RABBITS.

DISTRIBUTION AND HABITS.

Three kinds of rabbits occur in western Montana—the jack, the snowshoe, and the cottontail.

Probably the most important of these three species is the jackrabbit, an animal characteristic of open sagebrush plains and benches. Its young are born fully furred and with their eyes open.

The snowshoe rabbit, though characteristically a mountain animal, occurs in the brushy and timbered parts of the colder valleys. Though much larger than the cottontail, it has proportionately shorter legs and ears than the jack. In winter it turns snow white, except the tips of the ears, which are jet black. The young, like those of the jackrabbit, are born fully haired and with their eyes open.

Cottontail rabbits are common in brushy areas of all the valleys, except those in the extreme northwestern part of the State. They are small and do not turn white in winter. Cottontails produce several litters each year, and the young, unlike those of the snowshoe and jackrabbits, are born with their eyes closed and their bodies hairless.

RABBITS AS TICK HOSTS.

All three species are often very badly infested with ticks, over 700 having been found on a single snowshoe rabbit. Fortunately, however, these ticks usually belong to species which seldom attack domestic animals or human beings and are therefore comparatively unimportant. Nevertheless a few adult fever ticks have been found on rabbits.

INJURY TO CROPS AND FRUIT TREES.

Rabbits often injure garden truck, hay, and growing grain more or less seriously, but the greatest damage which they cause in fruit

FIG. 33.—Apple tree injured by rabbits.

districts is eating the bark of orchard trees. (Fig. 33.) This is usually done in the winter, when other food is covered with snow. Although apple and pear trees are most frequently attacked, cherry trees and others also occasionally suffer. Blackberry and raspberry bushes also are frequently injured. When the rabbits attack the bark of a tree they sink their big front teeth into it and pull it off in strips, sometimes repeating the process until large areas of bark are removed and the tree killed or seriously injured.

Although orchards are sometimes so badly damaged by rabbits as to require replanting, as a rule the depredations are not so serious. The following extract is from a letter written by the superintendent of an orchard company:

> The damage done by rabbits on the 1,000 acres planted amounted to about 3,000 to 3,500 trees out of a total of 130,192. On one special corner we had to replant 1,634 out of 1,971 trees.

RABBIT-PROOF FENCES.

Rabbit-proof fencing is one of the surest means of keeping the animals out of orchards and gardens, and is entirely effective except where drifted snow enables them to get over the fence. A netting of No. 18 or 20 galvanized iron wire, with 1½-inch mesh, and from 2½ to 3½ feet high is sufficient to exclude all rabbits. It may be used in combination with an ordinary wire fence. The lower edge of the netting should be turned outward for from 4 to 6 inches and covered with soil (with a plow); or a single closely barbed wire should be placed in contact with the surface of the ground.

TRUNK WASHES.

A large number of washes and paints designed to keep rabbits from eating the bark of trees have been tried, but most of them have proved utterly useless. Coal tar, pine tar, tarred paper, and various oils are likely to kill young trees; and while blood and animal fats are sometimes protective against rabbits when freshly applied, they are dangerous because attractive to meadow mice. Carbolic acid, though a favorite ingredient of these washes, evaporates so quickly that it is of no permanent value. The lime-and-sulphur wash so effective against the San Jose scale is probably the best and cheapest obtainable and, if thoroughly applied late in the fall, should remain effective throughout the winter. The following directions for its preparation and use are taken from an article by D. E. Lantz in the Yearbook of the Department of Agriculture for 1907:

Unslaked lime	pounds	20
Flowers of sulphur	do	15
Water to make	gallons	45–50

> A little salt [or glue] may be added to increase the adhesive property of the mixture. The lime, sulphur, and about a third of the water are boiled together for at least one hour, and the full quantity of water is then added. For San Jose scale the wash in the form of a spray is applied to the entire surface of the trees. For protection from mice and rabbits the trunks only require treatment, and the wash may be applied with a brush. One application in November should last the entire winter.

TRUNK WRAPPING.

The following directions for trunk wrapping are given by Professor Lantz in the article just mentioned:

Mechanical contrivances for protecting young orchard trees are many. Where protection from rabbits only is required, woven wire netting is recommended. This should be made of No. 20 galvanized wire, 1-inch mesh, such as is often used for poultry netting. For cottontail rabbits rolls 18 inches wide are recommended, but as a protection against jackrabbits wider material is safer. The wire is cut into 1-foot lengths, and one of these sections is rolled into shape about the trunk of each tree, the ends being brought together and fastened at several places by means of the wire ends. No other fastening is needed. The wire is not in contact with the trunk and may be left on the tree permanently. It will probably last as long as the tree requires protection, and the cost of material need not be over 1¾ cents for each tree. For young evergreens, material of the same kind 1 foot wide and cut in 1½-foot lengths will give excellent protection.

If trees are to be protected from both rabbits and mice, materials of closer mesh must be used. Wire window-screen netting is excellent for the purpose, and the cost, when permanence of protection is considered, is not great.

Veneer and other forms of wood protectors are popular and have several advantages. When left permanently upon the trees, however, they furnish retreats for insect pests. For this reason they should be removed each spring and laid away until cold weather. While the labor of removing and replacing them is considerable, they have the advantage, when pressed well into the soil, of protecting from both mice and rabbits. They cost from 60 cents per 100 upward, and are much superior to building paper or newspaper wrappings. The writer has known instances where rabbits tore wrappings of building paper from the apple trees and in a single night injured hundreds of them. "Gunnysack" and other cloth wrappings, well tied on, are effective protectors. Cornstalks also furnish a cheap material for orchard protection. They are cut into lengths of 18 to 20 inches, split, and tied with the flat side against the tree, so as fully to cover the trunk.

POISONING RABBITS.

Probably the most effective rabbit poison is strychnine-soaked alfalfa or clover hay, prepared as recommended for meadow mice in Formulas V and VI. This should be placed in rabbit runs or in other places frequented by the animals, and the time chosen should be late fall, winter, or early spring, when the natural food supply is at its lowest. Vegetables and apples, poisoned as recommended for pocket gophers in Formula VII, or by inserting crystals of strychnine sulphate in slits made with a knife, are also effective. Great care must be taken to keep poisoned hay and vegetables out of reach of stock.

RABBITS AS FOOD.

Cottontail and snowshoe rabbits are excellent when properly cooked; and though old jack rabbits are tough and dry, the young are tender and well flavored. Rabbits should always be parboiled, no

matter how they are finally cooked. They may be prepared in a variety of ways. A simple but excellent dish may be made by rolling each piece in seasoned flour or fine corn meal and frying in butter. They make good potpie when prepared like chicken. As stews, also, they are very palatable, and may be served with either brown or

FIG. 34.—Weasel, an active enemy of harmful rodents.

cream gravy. When rabbits are used for stews or pies it is well, after parboiling, to remove the meat from the bones.

BADGERS.

Badgers are common in many parts of western Montana. They live largely on Columbian and other ground squirrels, and their work may be seen in almost every squirrel colony. A badger which the

author kept alive for several weeks during the summer of 1911 was very fond of these rodents and sometimes ate three or four of them in a day. It also ate woodchucks, chipmunks, pine squirrels, and mice. From a study of the food habits of these animals it is evident that they must destroy large numbers of rodents, but the large mounds which they throw up in digging out the squirrel burrows are so great a nuisance in cultivated fields that many ranchers consider badgers as much of an annoyance as are the animals which they kill. Moreover, the badger is one of the few hosts of the adult wood tick and, since it is a comparatively wide-ranging animal, probably carries ticks from one locality to another. Thus, while the badger is a valuable destroyer of rodents, it is hard to urge its protection as strongly in fever-infested regions as in localities where its importance as a tick host need not be considered.

WEASELS.

Weasels occur more or less commonly in most parts of western Montana. (Fig. 34.) They live almost entirely on live animals—mice, ground squirrels, rabbits, and chipmunks being favorite food. A weasel kept in captivity by the writer for several weeks was easily able to kill the largest ground squirrels placed in its cage. Since in a state of nature adult weasels undoubtedly kill many rodents, it is evident that the animals are a valuable aid in the control of these pests. Extensive trapping of ground squirrels with "hole sets" usually results in the capture of one or more weasels.

Although the weasel is frequently infested with ticks, these are of species harmless to man and domestic stock; and the animal's relation to the spotted-fever problem seems to be wholly beneficial.

BIG GAME ANIMALS.

MOUNTAIN GOATS.

Mountain goats frequently serve as hosts for large numbers of adult and young wood ticks. On three goats shot on Rock Creek near Lake Como, in May, 1910, there were over 300 wood ticks. But since goats are not abundant and occur only far back in inaccessible parts of the mountains, there is no need to lessen the protection now furnished them as game animals.

ELK.

Elk are now so scarce in the area infested with spotted fever that they can not bear any very important relation to that disease. No ticks were found on the only elk examined during these investigations.

DEER.

Although many hunters say that deer frequently serve as hosts for wood ticks, none were found on any of the six black-tailed or the two

white-tailed deer examined during these investigations. There is no reason for removing the protection now granted these animals.

BEARS.

Black bears are common in the mountains in many parts of western Montana, and occasionally wander down into the bottom lands or cross from one range of mountains to another. Trappers say that bears are usually badly infested with wood ticks, and the author found a number on a brown bear shot near Woodman on June 30, 1910. Grizzly bears are much scarcer than black or brown bears and seldom leave the higher parts of the mountains.

COYOTES.

Coyotes are rather common throughout most of the western part of the State. Since they destroy sheep and poultry and frequently serve as hosts for adult wood ticks and are wide-ranging animals, it is important that their numbers be reduced as much as possible. This can best be accomplished by trapping, poisoning, and hounding. Full directions for destroying wolves and coyotes are given in Circular No. 63 of the Biological Survey.

SUMMARY.

Spotted fever is communicated from wild animals to human beings by the bite of infected wood ticks.

The most feasible ways of controlling the fever are: (1) To educate the inhabitants of infested localities in a belief in the "tick theory;" (2) to lessen the number of wood ticks, by (a) keeping domestic stock, the principal hosts of the adult ticks, tick free[1] and (b) lessening the number of native rodents, the necessary hosts of the younger states of the ticks; and (3) to destroy those native rodents which may serve as a source of continued reinfection of the ticks.

The destruction of harmful rodents in certain fever-infested parts of western Montana is doubly worth while, for there they not only are very destructive to crops, but are partly—probably fundamentally—responsible for the occurrence of the disease. Cooperation by all landowners in a district is essential to the success of any extensive campaign of rodent destruction. Poisons should be prepared in bulk by State experiment stations, counties, chambers of commerce, farmers' unions, or other organizations, and then distributed at cost to individuals.

By the adoption of these common-sense and comparatively simple methods there is every reason to believe that within a few years spotted fever in Montana will be practically a thing of the past.

[1] See Bulletin 105, Bureau of Entomology, U. S. Dept. Agriculture, 1911.